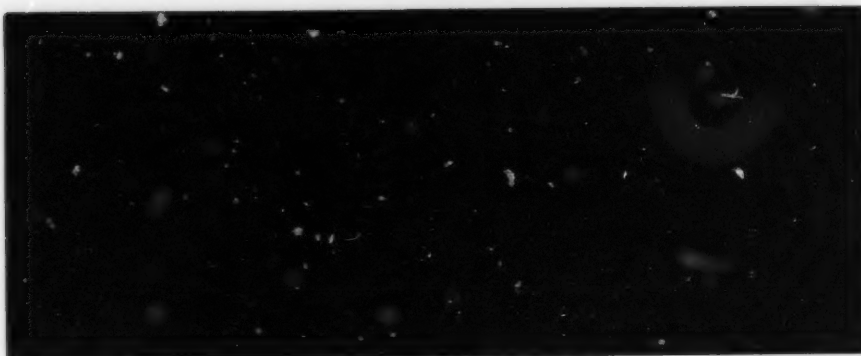


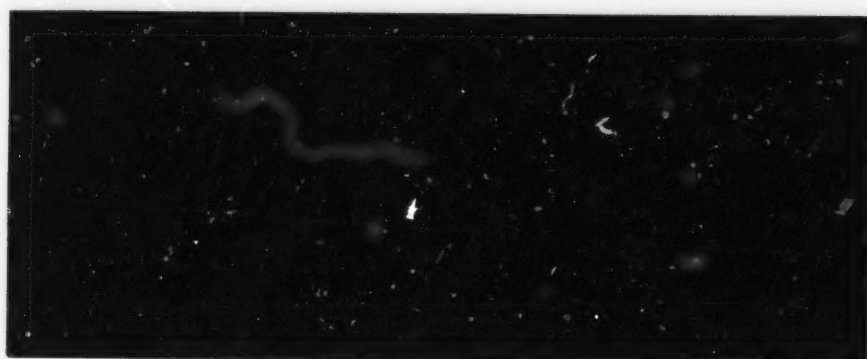
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An Evaluation of Alternative
Energy Sources for Swine

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AN EVALUATION OF ALTERNATIVE ENERGY SOURCES FOR SWINE

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A. EXECUTIVE SUMMARY

1. Abstract

Feed costs account for 50-80% of the total cost of raising a pig to market weight. Therefore, a reduction in feed costs will significantly increase the profit potential of swine production in Saskatchewan. Barley is the most widely utilized feed grain in western Canada and forms the foundation of most diets fed to swine. However, new feedstuffs become available from time to time, which may have potential for use in swine rations. It is extremely important that these alternative energy sources be evaluated so that Saskatchewan's swine producers can continue to provide economical as well as nutritionally balanced diets during all phases of the life cycle of the pig. In the preliminary year of this study, several feedstuffs were evaluated. Those which may have potential to be utilized in swine rations include enzymatically treated rye, hulless barley and wild oat groats.

2. Summary

A series of experiments was conducted to evaluate enzymatically treated rye, hulless barley and wild oat groats as potential feedstuffs for use in swine rations. In the first experiment, forty-eight weanling pigs weighing approximately 25 kg were assigned to one of three dietary treatments in an experiment designed to determine if the performance of pigs fed rye based diets can be improved by supplementation with a enzyme capable of breaking down soluble pentosans. The diets for this experiment consisted of a barley-based control diet or a rye-based diet supplemented or unsupplemented with a dietary enzyme with pentosanase activity.

In general, digestibility coefficients for dry matter, crude protein and energy were higher for pigs fed rye-based diets in comparison with barley. However, enzyme supplementation did not appear to have a significant effect on the digestibility of any of the nutrients measured. Pigs fed the control diet gained weight at a rate approximately 5% faster than pigs fed the unsupplemented rye-based diet (0.80 vs 0.76 kg/day). Supplementation of the rye-based diet with pentosanase, resulted in a rate of gain intermediate to that of pigs fed the other two diets (0.78 kg/day). In addition, there was a significant ($P < 0.05$) improvement in feed efficiency for the pigs fed both the supplemented and unsupplemented rye-based diet. There were no significant differences ($P > 0.05$) in slaughter weight, carcass weight, dressing percentage, estimated lean yield or carcass value index as a result of differences in the cereal base of the diet or as a result of enzyme supplementation.

The overall results of this experiment provide a favorable indication that low-ergot rye supplemented with pentosanase may have potential as an alternative energy source for use in swine rations. Under the conditions of this experiment, pigs fed rye-based diets reached market weight approximately 2.5 days later than pigs fed the barley-based control diet but were more efficient in utilizing their feed. This improvement in feed efficiency may provide sufficient incentive to encourage the incorporation of rye into swine rations, particularly when the cost of other cereal grains is high.

A second experiment was conducted to compare the nutritive value of Scout barley with that of a recently developed, hulled variety of barley, licensed under the name of Harrington. Sixty crossbred pigs weighing 20 ± 2 kg were fed diets based on either hulled (Harrington) or hulless (Scout) barley. The pigs were housed ten to a pen (five barrows and five gilts) in partially slatted concrete floors and were weighed at weekly intervals. Feed consumption was determined on a pen basis at the time of the weekly weighing.

The digestibility coefficient for crude protein was slightly lower for the diet containing Scout barley than the diet containing Harrington barley (75.1 vs 78.3%) while digestibility coefficients for dry matter (80.5%) and energy (78.0%) did not differ between treatments. There was no significant difference in the average daily gain of pigs fed diets based on Scout or Harrington barley (0.74 vs 0.75 kg/day) while the feed intake of pigs fed the diets based on Scout barley tended to be lower than that of pigs fed Harrington barley (2.32 vs 2.46 kg/day). The feed efficiency of pigs fed Scout barley was significantly better ($P < 0.05$) than that of pigs fed diets based on Harrington barley (3.13 vs 3.30). There were no significant differences in carcass traits between pigs fed diets based on Harrington or Scout barley. The overall results of this experiment suggest that hulless Scout barley may be superior to hulled Harrington barley for use in swine rations.

A third experiment was conducted to compare the nutritive value of wild and domestic oat groats in starter rations for swine. Three replicates of 60, four week old weaner pigs were assigned to one of five dietary treatments. The control diet was based on wheat and soybean meal while the remaining diets contained 25% domestic oat groats, wild oat groats, toasted oat flakes (feed oats) or toasted wild oat flakes added at the expense of wheat.

Pigs fed the diet containing oat groats had the highest average daily gain (399 g) followed by pigs fed the wheat based control diet (393 g), feed oats (378 g), wild oat groats (371 g) and wild oat flakes (350 g). Pigs fed oat groats had the highest average daily feed (648 g) followed by pigs fed feed oats (646 g), the wheat based control (644 g), wild oat groats (610 g) and wild oat flakes (598 g).

Feed conversion efficiency was approximately the same for all treatments (1.65 g feed/ g gain). Digestibility coefficients were highest for the control diet and lowest for the diet containing oat groats. Toasting and rolling produced only marginal improvements in digestibility over that obtained with the unprocessed groat. However, none of these differences were statistically significant.

The overall results of this experiment indicate that the nutritive value of wild oat groats is comparable to domestic oat groats. This could make available to the swine industry a valuable feed resource from a previously unused product.

B. TECHNICAL REPORTS

- 1. The Effect of Enzymatic Treatment of Rye on its Nutritive Value for Swine.**
- 2. The Nutritive Value of Hulless Barley for Swine.**
- 3. The Effect of Beta-Glucanase Supplementation on the Performance of Pigs Fed Hulless Barley.**
- 4. Performance of Starter Pigs Fed Hulled and Hulless Barley-Based Diets Supplmented or Unsupplemented with Beta-Glucanase Enzyme.**
- 5. Use of Wild Oat Groats in Starter Rations for Swine.**

THE EFFECT OF ENZYMATIC TREATMENT OF RYE ON ITS NUTRITIVE VALUE FOR SWINE

P. A. Thacker, G.L. Campbell and J. Grootwassink

INTRODUCTION

From an agronomic standpoint, rye is an attractive crop for western Canada. Rye produces higher yields of grain than other cereals particularly on poor quality, sandy soils and assists in better management of the soil by minimizing wind erosion. Rye is traditionally sown in the fall and therefore makes more effective use of water during spring run-off than cereals planted in the spring. In addition, rye production allows for a more equitable distribution of a farmers workload as a result of its early harvest.

Unfortunately, the market potential for rye is limited as it is not readily accepted into many types of animal feeds. The classical explanation for this relates to the high ergot content of rye. However, recent research with poultry indicates that high levels of soluble pentosans may pose an even greater problem than does ergot. These pentosans are solubilized during digestion, resulting in a highly viscous intestinal fluid that interferes with digestion. Recently, enzymes have been produced which break down the soluble pentosans in rye. Treatment of rye with these enzymes could improve its nutritional value and make available to the swine industry an alternative feed resource.

OBJECTIVES

- (1) To determine if the performance of pigs fed rye based diets can be improved by supplementation with a enzyme capable of breaking down soluble pentosans.
- (2) To determine the effect of enzyme supplementation on the digestibility of dry matter, crude protein and energy for pigs fed diets containing rye as the major cereal.

EXPERIMENTAL PLAN

Forty-eight weanling pigs weighing approximately 25 kg were assigned on the basis of sex, weight and litter to one of three dietary treatments (Table 1). The diets for this experiment consisted of a barley-based control diet or a rye-based diet supplemented or unsupplemented with a dietary enzyme with pentosanase activity. The rye used in this experiment was of the variety Musketeer and contained less than 0.05% ergot.

The pigs received diets containing 17% crude protein until they reached a weight of 55 kg at which time the protein content of the diet was reduced to 14%. All other nutrients were present in

sufficient amounts to meet or exceed requirements. All diets were fed in pelleted form.

The pigs were housed, four to a pen (two barrows and 2 gilts), in concrete floored pens measuring 2.7 x 3.6 m. They were allowed access to a self-feeder for 30 minutes, twice daily. Water was available ad libitum throughout the experiment. The pigs were weighed at weekly intervals and feed consumption was determined on an individual basis at the time of the weekly weighing. Individual pigs were slaughtered at an average weight of 98 kg at which time, carcass weight was recorded and backfat measurements made. These values were then utilized in calculating Carcass Value Indices.

The digestibility of dry matter, crude protein and energy was determined by the addition of 0.5% chromic oxide to the experimental diets. Four pigs (two barrows and two gilts), were fed one of the chromic oxide containing diets for 7 days. Fecal samples were collected from each pig during day 6 and 7. Samples of feed and feces were then taken to the laboratory for subsequent analysis.

RESULTS AND DISCUSSION

A chemical analysis of the experimental diets is presented in Table 1. The dry matter content and the level of crude protein, ether extract and ash was similar for all diets. However, the level of acid detergent fiber was approximately 50 % lower in the rye-based diets reflecting the lower fiber content of rye vs barley.

The effect of enzyme supplementation on the digestibility of dry matter, crude protein and energy is shown in Table 2. In general, digestibility coefficients were higher for pigs fed rye-based diets in comparison with barley. However, enzyme supplementation did not appear to have a significant effect on the digestibility of any of the nutrients measured.

The effect of enzyme supplementation on pig performance is shown in Table 3. Pigs fed the control diet gained weight at a rate approximately 5% faster than pigs fed the unsupplemented rye-based diet (0.80 vs 0.76 kg/day). Supplementation of the rye-based diet with pentosanase, resulted in a rate of gain intermediate to that of pigs fed the other two diets (0.78 kg/day).

The average daily feed intake of pigs fed the rye-based diets was approximately 7% less than that of pigs fed the barley-based control. This reduction in feed intake was reflected in a significant ($P < 0.05$) improvement in feed efficiency for the pigs fed both the supplemented and unsupplemented rye-based diet.

The effect of enzyme supplementation on the carcass traits of the experimental pigs is presented in Table 4. There were no significant differences ($P > 0.05$) in slaughter weight, carcass weight, dressing percentage, estimated lean yield or carcass value index as a result of differences in the cereal base of the diet or as a result of enzyme supplementation.

In assessing the full potential of enzyme supplementation as a means of improving the nutritive value of rye, it is important to

point out that all of the diets used in this experiment were pelleted. Pelleting has been shown to improve the nutritional value of unsupplemented rye-based diets which may have left less room for improvement by the enzyme. However, even under the conditions of this experiment, supplementation with pentosanase resulted in modest improvements in average daily gain and feed efficiency.

CONCLUSIONS AND IMPACT

The overall results of this experiment provide a favorable indication that low-ergot rye supplemented with pentosanase may have potential as an alternative energy source for use in swine rations. Under the conditions of this experiment, pigs fed rye-based diets reached market weight approximately 2.5 days later than pigs fed the barley-based control diet but were more efficient in utilizing their feed. This improvement in feed efficiency may provide sufficient incentive to encourage the incorporation of rye into swine rations, particularly when the cost of other cereal grains is high.

ACKNOWLEDGEMENTS

This study was funded by a grant from the Agriculture Development Fund. The efforts of the staff at the Campus Swine Barn in the feeding and care of the experimental animals are gratefully acknowledged.

	Growing			Finishing		
	Control	Rye	Rye + Enzyme	Control	Rye	Rye + Enzyme
<u>Ingredients</u>						
Barley	80.10	-----	-----	85.85	-----	-----
Rye	-----	79.00	78.75	-----	84.65	84.40
Soybean meal	15.15	16.25	16.25	9.40	10.60	10.60
Limestone	1.50	1.50	1.50	1.50	1.50	1.50
Dical	1.50	1.50	1.50	1.50	1.50	1.50
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Premix ¹	0.25	0.25	0.25	0.25	0.25	0.25
Tallow	1.00	1.00	1.00	1.00	1.00	1.00
Enzyme	----	----	0.25	----	----	0.25
<u>Nutrient Analysis</u>						
Dry matter	88.63	88.17	88.15	89.40	88.52	88.26
Crude protein	17.30	16.80	17.30	15.20	14.30	14.10
Acid detergent fiber	5.88	3.01	3.12	-----	-----	-----
Ether extract	3.05	2.58	2.77	2.47	2.61	2.35
Ash	5.70	5.08	5.17	6.11	5.05	4.96

¹ Supplied per kg diet: 4125 I.U. vitamin A; 275 I.U. vitamin D₃; 13.5 I.U. vitamin E; 2 mg vitamin K; 0.5 mg thiamin; 4 mg riboflavin; 22 mg niacin; 16.5 mg pantothenic acid; 14 ug vitamin B₁₂; 250 mg choline chloride; 0.12 mg biotin; 3 mg copper; 40 mg iron; 21.3 mg manganese; 76.5 mg zinc; 0.05 mg selenium.

crude protein and energy for growing pigs fed rye-based diets.

	Control	Rye	Rye + Enzyme
Dry Matter (%)	79.8	82.9	81.7
Crude protein (%)	76.8	76.9	77.3
Energy (%)	78.3	81.2	80.1

	<u>Control</u>	<u>Rye</u>	<u>Rye + Enzyme</u>	<u>S.E.</u>
Average daily gain (kg)	0.80	0.76	0.78	0.02
Average daily feed (kg)	2.19	2.02	2.06	0.07
Feed efficiency	2.74a	2.66b	2.64b	0.03

	<u>Control</u>	<u>Rye</u>	<u>Rye + Enzyme</u>	<u>S.E.</u>
Slaughter weight (kg)	97.5	97.4	98.7	1.3
Carcass weight (kg)	76.1	76.8	78.5	1.0
Dressing percentage (%)	78.0	78.8	79.5	0.4
Estimated lean yield (%)	49.3	48.9	49.1	0.4
Carcass value index	104.3	103.0	104.3	1.1

THE NUTRITIVE VALUE OF HULLESS BARLEY FOR SWINE

P.A. Thacker, J.M. Bell, H.L. Classen,
G.L. Campbell and B.G. Rossnagel

INTRODUCTION

Barley has traditionally been considered as an inferior feed grain, relative to corn or wheat, for fattening pigs. The major factor responsible for the lower nutritional value of barley is its relatively high hull content. Recently, a new variety of barley was developed by researchers at the University of Saskatchewan, which loses its hull during the normal harvesting operation. This cultivar called Scout is lower in fiber and higher in digestible energy than are other barleys. As a consequence, it may be superior to other barleys as a feedstuff for swine. This experiment was conducted to compare the nutritive value of Scout barley with that of a another recently developed, hulled variety of barley, licensed under the name of Harrington.

OBJECTIVES

- (1) To compare the performance of swine fed diets containing hulled or hulless barley.
- (2) To determine the digestibility of dry matter, protein and energy in diets containing hulled or hulless barley.
- (3) To determine if feeding hulless barley has any effects on backfat levels and carcass composition of market hogs.

EXPERIMENTAL PLAN

Sixty crossbred pigs (Yorkshire x Landrace) weighing 20 ± 2 kg were assigned on the basis of sex, weight and litter to one of two experimental diets based on either hulled (cv Harrington) or hulless barley (cv Scout). The pigs received diets containing 17% crude protein until they reached 55 kg at which time the protein content of the diet was reduced to 15% (Table 2). All other nutrients were present in sufficient amounts to meet or exceed requirements.

The pigs were housed ten to a pen (five barrows and five gilts) in partially slatted concrete floored pens measuring 4.7 x 1.5 m. Pigs were weighed at weekly intervals and feed consumption was determined on a pen basis at the time of the weekly weighing. Feed and water were available ad libitum throughout the experiment. Individual pigs were slaughtered at an average weight of 98 kg, at which time carcass weight was recorded and backfat measurements made. These values were then utilized in calculating Carcass Value Indices.

The digestibility of dry matter, crude protein and energy in the hulled and hulless barley was determined by the addition of 0.5% chromic oxide to the experimental diets. Four pigs (two barrows and two gilts), were fed one of the chromic oxide containing diets for 10

days. Fecal samples were collected from each pen during day 9 and 10. Samples of feed and feces were then taken to the laboratory for subsequent analysis.

RESULTS AND DISCUSSION

A chemical analysis was performed on the Scout and Harrington barley and the results are presented in Table 1. The Scout barley used in this experiment contained a higher crude protein content and a lower acid detergent fiber level in comparison with the Harrington. The bushel weight of the Harrington barley was 51.9 pounds per bushel while the Scout barley had a bushel weight of 55.4 pounds per bushel.

The results of the chemical analysis of the experimental diets are presented in Table 2. The crude protein content of diets containing Scout barley were slightly higher than that of the diets containing Harrington barley. Diet formulation at this higher protein level was necessary in order to ensure that both diets provided approximately the same amount of the amino acid lysine. As expected, the diets based on Scout barley were lower in acid detergent fibre than diets based on Harrington barley. The ether extract and ash level did not differ appreciably between diets.

Digestibility coefficients for dry matter, crude protein and energy are shown in Table 3. The digestibility coefficient for crude protein was slightly lower for the diet containing Scout barley in comparison with the diet containing Harrington (75.06 vs 78.28 %). Digestibility coefficients for dry matter (80.51 vs 80.58%) and energy (78.04 vs 77.97%) did not appear to differ between treatments.

Pigs fed diets based on hulless barley gained at approximately the same rate as those pigs fed hulled barley (0.74 vs 0.75 kg/day; Table 4). However, the feed intake of pigs fed the diets based on hulless barley was lower than that of pigs fed the hulled barley diet (2.32 vs 2.46 kg/day). As a consequence, feed conversion was significantly better ($P < 0.05$) for pigs fed the hulless barley compared with the hulled barley (3.13 vs 3.30). Based on this result, it is estimated that pigs fed Scout barley would require approximately 13 kg less feed to reach market weight than pigs fed hulled barley.

A comparison of carcass data for pigs fed the hulled and hulless barley is shown in Table 5. Slaughter weight, carcass weight, dressing percentage, backfat level and carcass grade were not affected by treatment.

It should be noted that the hulled barley used as the control in this experiment was of very high quality with a bushel weight of 51.9 pounds compared with an average bushel weight for hulled barley of 48 pounds. Larger differences in pig performance would likely have been obtained had the Scout barley be compared to a barley with a nutritional quality more typical of that commonly grown in Saskatchewan.

CONCLUSIONS AND IMPACT

The overall results of this experiment indicate that the digestibility of crude protein may be higher in hulless barley compared with hulled barley. Pigs fed the diets based on hulless barley gained at approximately the same rate as did those fed diets based on hulled barley but with a significantly improved feed conversion. Therefore, it appears that hulless barley may be superior to hulled barley as a feedstuff for use in swine rations.

ACKNOWLEDGEMENTS

The study was funded by a grant from the Western Grains Research Foundation. The efforts of Brian Andries and Karen Wurtz in the care and management of the experimental animals is gratefully acknowledged.

Table 1. Nutrient analysis of hulled and hullless barley

<u>Criteria</u>	<u>Harrington</u>	<u>Scout</u>
Moisture	13.32	9.95
Crude protein	13.34	14.97
Acid detergent fibre	5.10	2.83
Ether extract	2.06	2.18
Ash	1.62	1.88
Bushel weight (lbs)	51.92	55.44

Table 2. Formulation and chemical analysis of experimental diets

<u>Ingredients</u>	<u>Growing</u>		<u>Finishing</u>	
	<u>Harrington</u>	<u>Scout</u>	<u>Harrington</u>	<u>Scout</u>
Barley	85.75	88.05	89.45	91.45
Soybean meal (46.5%)	11.00	8.70	7.30	5.30
Salt (iodized)	0.50	0.50	0.50	0.50
Limestone	1.25	1.25	1.25	1.25
Dicalcium phosphate	1.25	1.25	1.25	1.25
Vitamin-mineral premix ¹	0.25	0.25	0.25	0.25
<u>Nutrient Analysis</u>				
Dry matter	87.20	89.20	87.85	89.99
Crude protein	16.30	17.41	14.85	15.30
Acid detergent fiber	5.59	2.90	5.81	2.49
Ether extract	1.93	2.05	2.24	2.18
Ash	4.69	4.19	4.02	4.31
Calcium	0.80	0.70	0.62	0.85
Phosphorus	0.57	0.61	0.55	0.71

¹ Supplied per kg diet: 4125 I.U vitamin A; 275 I.U. vitamin D₃; 13.5 I.U. vitamin E; 2 mg vitamin K; 0.5 mg thiamin; 4 mg riboflavin; 22 mg niacin; 16.5 mg pantothenic acid; 14 ug vitamin B₁₂; 250 mg choline chloride; 0.12 mg biotin; 3 mg copper; 40 mg iron; 21.3 mg manganese; 76.5 mg zinc; 0.05 mg selenium.

Table 3. Digestibility coefficients for dry matter, crude protein and energy

	<u>Harrington</u>	<u>Scout</u>
Dry matter (%)	80.56	80.51
Crude protein (%)	78.28	75.06
Energy (%)	79.04	77.97

Table 4. Performance of pigs fed diets based on hulled or hulless barley.

	<u>Harrington</u>	<u>Scout</u>
Average daily gain (kg)	0.75	0.74
Average daily intake (kg)	2.46	2.32
Feed conversion	3.30a	3.13b

¹ Means followed by a different letter are significantly different ($P < 0.05$).

Table 5. Carcass traits of pigs fed diets based on hulled and hulless barley

<u>Criteria</u>	<u>Harrington</u>	<u>Scout</u>
Slaughter weight (kg)	98.0	97.8
Carcass weight (kg)	79.0	78.2
Dressing percentage (%)	80.6	79.8
Backfat (cm)	3.5	3.5
Carcass value index	103.7	103.6

THE EFFECT OF BETA-GLUCANASE SUPPLEMENTATION ON THE PERFORMANCE OF PIGS FED HULLESS BARLEY

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INTRODUCTION

The aleurone layer and the endosperm of barley kernels contain a water soluble polysaccharide called beta-glucan which consists of glucose units linked together by beta-1,4 and beta-1,3 linkages. The beta-1,3 linkages confer upon the molecule a step-like structure that interferes with hydrogen bonding between adjacent chains resulting in increased water solubility.

Beta-glucans have been shown to lower the nutritional value of barley by increasing the viscosity of the intestinal fluid. This interferes with the digestive process by impeding enzyme-substrate association and reducing the rate at which released nutrients approach the mucosal surface for absorption. It has also been suggested that beta-glucans allow intestinal bacteria to assimilate more of the nutrients contained in a feed into their own system thus reducing the availability of these nutrients to the host.

Treatment of barley with an enzyme capable of breaking down the beta-glucans (beta-glucanase) has been shown to improve the nutritive value of barley for poultry. There has been little research conducted to determine the effects of beta-glucans on the performance of swine. Since the hulless varieties of barley have been reported to contain higher levels of beta-glucans than the hulled varieties, an experiment was conducted to determine if the performance of pigs fed diets based on hulless barley could be improved by supplementation with beta-glucanase.

OBJECTIVES

- (1) To compare the performance of swine fed diets based on hulless barley, supplemented or unsupplemented with beta-glucanase.
- (2) To determine the digestibility of dry matter, protein and energy in hulless barley-based diets supplemented or unsupplemented with beta-glucanase.
- (3) To determine if dietary supplementation with beta-glucanase has any effects on backfat levels and carcass composition of market hogs fed diets based on hulless barley.

EXPERIMENTAL PLAN

Sixty crossbred pigs (Yorkshire x Landrace) weighing 20 ± 2 kg were assigned on the basis of sex, weight and litter to one of two experimental diets. The experimental diets were based on hulless barley (cv Scout) and were fed either supplemented or unsupplemented:

protein until they reached 35 kg at which time the protein content of the diet was reduced to 15% (Table 1). All other nutrients were present in sufficient amounts to meet or exceed requirements.

The pigs were housed ten to a pen (five barrows and five gilts) in partially slatted concrete floored pens measuring 4.7 x 1.5 m. Pigs were weighed at weekly intervals and feed consumption was determined on a pen basis at the time of the weekly weighing.

Feed and water were available ad libitum throughout the experiment. Individual pigs were slaughtered at an average weight of 98 kg, at which time carcass weight was recorded and backfat measurements made. These values were then utilized in calculating Carcass Value Indices.

The effect of enzyme supplementation on the digestibility of dry matter, crude protein and energy was determined by the addition of 0.5% chromic oxide to the experimental diets. Eight pigs (four barrows and four gilts), were fed diets containing chromic oxide for 10 days. Fecal samples were collected from each pen during day 9 and 10. Samples of feed and feces were then taken to the laboratory for subsequent analysis.

RESULTS AND DISCUSSION

The results of the chemical analysis of the experimental diets are presented in Table 1. As expected, there was no difference in chemical composition between the experimental diets as a result of enzyme supplementation.

Digestibility coefficients for dry matter, crude protein and energy are presented in Table 2. Although not tested statistically, supplementation of the hulless barley diet with beta-glucanase appeared to increase the digestibility of dry matter (82.69 vs 80.51 %), crude protein (77.72 vs 75.06 %) and energy (80.82 vs 77.97). These increases likely arose from a decrease in the viscosity of the intestinal fluid resulting in improved enzyme-substrate association.

Pigs fed the unsupplemented hulless barley diet gained at approximately the same rate as those pigs fed the hulless barley diet supplemented with beta-glucanase (0.74 vs 0.76 kg/day; Table 3). In addition, there was little difference in the feed intake of pigs fed the supplemented and unsupplemented diets (2.32 vs 2.35 kg/day). As a consequence, feed conversion efficiency did not differ between treatments (3.13 vs 3.11).

The effect of beta-glucanase supplementation on the carcass composition of pigs fed hulless barley is shown in Table 4. Beta-glucanase supplementation had no effect on slaughter weight, carcass weight, dressing percentage, backfat level or carcass grade.

CONCLUSIONS AND IMPACT

The overall results of this experiment indicate that the digestibility of dry matter, crude protein and energy can be

<u>Ingredients</u>	<u>Growing</u>		<u>Finishing</u>	
	<u>Control</u>	<u>Enzyme</u>	<u>Control</u>	<u>Enzyme</u>
Barley	88.05	87.80	91.45	91.20
Soybean meal (46.5%)	8.70	8.70	5.30	5.30
Salt (iodised)	0.50	0.50	0.50	0.50
Limestone	1.25	1.25	1.25	1.25
Dicalcium phosphate	1.25	1.25	1.25	1.25
Vitamin-mineral premix ¹	0.25	0.25	0.25	0.25
Enzyme	---	0.25	---	0.25

Nutrient Analysis

Dry matter	89.20	89.70	89.88	89.95
Crude protein	17.41	17.40	15.30	15.30
Acid detergent fibre	2.90	2.86	2.49	2.20
Ether extract	2.05	2.07	2.18	2.17
Ash	4.19	4.89	4.31	3.96
Calcium	0.69	0.90	0.85	0.65
Phosphorus	0.61	0.72	0.71	0.65

¹ Supplied per kg diet: 4125 I.U. vitamin A; 275 I.U. vitamin D₃; 13.5 I.U. vitamin E; 2 mg vitamin K; 0.5 mg thiamin; 4 mg riboflavin; 22 mg niacin; 16.5 mg pantothenic acid; 14 µg vitamin B₁₂; 250 mg choline chloride; 0.12 mg biotin; 3 mg copper; 40 mg iron; 21.3 mg manganese; 76.5 mg zinc; 0.05 mg selenium.

Table 2. Digestibility coefficients for dry matter, crude protein and energy

	<u>Control</u>	<u>Enzyme</u>
Dry matter (%)	80.51	82.69
Crude protein (%)	75.06	77.72
Energy (%)	77.97	80.82

increased by supplementing diets containing hulless barley with beta-glucanase. However, this increase in digestibility was not reflected in the performance of the pigs fed the diet supplemented with beta-glucanase. In addition, carcass traits were unaffected by treatment. Therefore, while it appeared as though there was some benefit from supplementing hulless barley diets fed to growing/finishing pigs with beta-glucanase, the overall response was slight and the practice cannot be recommended at the present time.

ACKNOWLEDGEMENTS

The study was funded by a grant from the Western Grains Research Foundation. The efforts of Brian Andries and Karen Wurtz in the care and management of the experimental animals is gratefully acknowledged.

Table 3. Effect of beta-glucanase supplementation on pig performance

	<u>Control</u>	<u>Enzyme</u>
Average daily gain (kg)	0.74	0.76
Average daily intake (kg)	2.32	2.35
Feed conversion efficiency	3.13	3.11

Table 4. Effect of beta-glucanase supplementation on swine carcass traits

	<u>Control</u>	<u>Enzyme</u>
<u>Criteria</u>		
Slaughter weight (kg)	98.0	98.0
Carcass weight (kg)	78.2	79.1
Dressing percentage (%)	79.8	80.7
Backfat (cm)	3.5	3.7
Carcass value index	103.6	102.8

PERFORMANCE OF STARTER PIGS FED HULLED AND HULLESS
BARLEY-BASED DIETS SUPPLEMENTED OR UNSUPPLEMENTED
WITH BETA-GLUCANASE ENZYME

P.A. Thacker

INTRODUCTION

Barley is not widely utilized in diets fed to starter pigs because it contains a higher level of crude fiber and a lower level of digestible energy than does wheat. However, researchers at the University of Saskatchewan have recently developed a new variety of barley which loses its hull during the normal harvesting operation. This cultivar called Scout is lower in fiber and higher in digestible energy than are other barleys. As a consequence, it may have more potential for inclusion in diets fed to starter pigs than does hulled barley.

Unfortunately, the beta-glucan content of hulless barley has been shown to be much higher than that found in hulled barley. Beta-glucans are a water soluble polysaccharide which are known to increase intestinal viscosity. This increase in intestinal viscosity has been postulated to interfere with the digestive process and thereby affect pig performance.

Treatment of barley with an enzyme capable of breaking down the beta-glucans (beta-glucanase) has been shown to improve the nutritive value of barley. Therefore, this experiment was conducted to compare the performance of starter pigs fed hulled or hulless barley-based diets either supplemented or unsupplemented with a beta-glucanase enzyme.

OBJECTIVES

1. To compare the performance of starter pigs fed hulled or hulless barley-based diets either supplemented or unsupplemented with beta-glucanase.
2. To determine the digestibility of dry matter, crude protein and energy in hulled or hulless barley-based diets either supplemented or unsupplemented with beta-glucanase.

EXPERIMENTAL PLAN

Three replicates of 56, four week old weaner pigs were assigned on the basis of sex, weight and litter on one of five dietary treatments. The control diet for this experiment was based on wheat while the remaining four diets were based on either hulled (cv Harrington) or hulless (cv Scout) barley (Table 1). All diets were formulated to contain approximately 18.5% crude protein by supplementation with soybean meal and contained sufficient other nutrients to meet or exceed NRC requirements (Table 2). In addition, the barley diets were fed either supplemented or unsupplemented with a beta-glucanase enzyme.

The experimental animals were housed in pairs (2 barrows or 2 gilts) in 0.6 x 1.2 m pens with a totally slatted-floor. The pigs

were weighed at weekly intervals and feed consumption was determined at the time of the weekly weighing. Water was available ad libitum throughout the five week feeding period.

The digestibility of dry matter, crude protein and energy was determined by the addition of 0.5% chromic oxide to the experimental diets. Twelve pigs (six barrows and six gilts), were fed one of the chromic oxide containing diets for a period of 10 days. Fecal samples were collected from each pen during day 9 and 10. Samples of feed and feces were then taken to the laboratory for subsequent analysis.

RESULTS AND DISCUSSION

The results of a chemical analysis performed on the experimental diets are presented in Table 3. As expected, the diets based on hulless barley were lower in acid detergent fiber than the diets based on hulled barley. However, there was little difference among diets as to the levels of moisture, crude protein, ash and ether extract they contained. The lysine content of the wheat-based control was slightly below requirement (0.76 vs 0.79 %) whereas all of the barley-based diets provided sufficient amounts of the essential amino acids to meet NRC requirements.

Digestibility coefficients for dry matter, crude protein and energy for the starter pigs fed hulled and hulless barley-based diets are presented in Table 4. Digestibility coefficients for dry matter, crude protein and energy were significantly ($P < 0.05$) higher for pigs fed the hulless barley-based diets in comparison with the diets based on hulled barley or wheat. Digestibility coefficients obtained from pigs fed the wheat-based control or hulled barley were not significantly different. Enzyme supplementation of either the hulled or hulless barley did not appear to affect the digestibility of any of the nutrients measured.

Performance data for the pigs fed the experimental diets is compared in Table 5. Despite the higher digestibility coefficients obtained for pigs fed Scout barley, there were no significant differences in average daily gain, average daily feed and feed efficiency between pigs fed hulled barley, hulless barley or wheat. In addition, enzyme supplementation did not appear to have any effect on animal performance.

CONCLUSIONS AND IMPACT

The overall results of the experiment suggest that hulless barley of high quality, hulled barley may be used in starter diets as a replacement for wheat. Enzyme supplementation did not appear to be beneficial in improving the performance of starter pigs fed diets based on either hulled or hulless barley.

ACKNOWLEDGEMENTS

This study was supported by the Province of Saskatchewan's Agricultural Development Fund and by a grant from the Western Grains Research Foundation. The author also like to thank Ben Zorman and Richard Hartman for care and management of the experimental animals.

Table 1. Chemical analysis of Scout and Harrington barley.

	<u>Harrington</u>	<u>Scout</u>
<u>Criteria :</u>		
Moisture	13.3	10.0
Crude protein	13.3	14.9
Acid detergent fiber	5.1	2.8
Ether extract	2.1	2.8
Ash	1.6	1.9
Bulk weight (kg/hl)	64.7	68.7

Table 2. Formulation of experimental diets.

Ingredient (%)	Control	Harrington	Harrington + Enzyme	Scout	Scout + Enzyme
	-----	-----	-----	-----	-----
Wheat	79.75	-----	-----	-----	-----
Barley	-----	75.00	74.75	78.50	78.25
Soybean meal	14.00	18.75	18.75	15.25	15.25
Limestone	1.25	1.25	1.25	1.25	1.25
Dicalcium Phosphate	1.50	1.50	1.50	1.50	1.50
Salt (iodized)	0.50	0.50	0.50	0.50	0.50
Tallow	2.50	2.50	2.50	2.50	2.50
Premix	0.50	0.50	0.50	0.50	0.50
Enzyme	-----	-----	0.25	-----	0.25

¹ Supplied per kg of diet: 8250 I.U. vitamin A; 550 I.U. vitamin D₃; 27 I.U. vitamin E; 4 mg vitamin K; 1 mg thiamin; 8 mg riboflavin; 44 mg niacin; 33 mg pantothenic acid; 28 ug vitamin B₁₂; 500 mg choline chloride; 0.25 mg biotin; 6 mg copper; 80 mg iron; 24.7 mg manganese; 153 mg zinc; 0.1 mg selenium.

Table 3. Chemical analysis of the experimental diets.

	Control	Harrington	Harrington + Enzyme	Scout	Scout + Enzyme
Moisture	89.73	90.66	90.70	91.21	91.52
Crude protein	18.00	19.00	18.30	19.00	19.40
Acid detergent fibre	3.75	5.36	5.34	3.11	2.86
Ash	4.14	4.68	4.39	4.66	4.56
Ether extract	4.47	4.24	4.58	4.51	4.65
Calcium	0.87	0.95	0.89	1.03	0.88
Phosphorus	0.66	0.59	0.64	0.72	0.70
<u>Amino Acids (%)</u>					
Arginine	1.07	1.16	1.16	1.12	1.12
Histidine	0.56	0.59	0.59	0.55	0.55
Isoleucine	0.74	0.75	0.79	0.76	0.75
Leucine	1.26	1.42	1.43	1.38	1.43
Lysine	0.76	0.90	0.88	0.90	0.91
Methionine	0.24	0.24	0.25	0.25	0.26
Phenylalanine	0.91	1.02	1.03	1.00	1.02
Threonine	0.61	0.68	0.69	0.66	0.66
Valine	0.83	0.91	0.91	0.92	0.92

Table 4. Digestibility coefficients for starter pigs fed hulled or hulless barley diets.

<u>Diet</u>	<u>Dry Matter</u>	<u>Crude Protein</u>	<u>Energy</u>
Control	85.2b	83.6b	85.0b
Harrington	83.4b	85.3ab	83.6b
Harrington + Enzyme	84.6b	85.9ab	84.6b
Scout	88.3a	87.0ab	88.6a
Scout + Enzyme	87.9a	87.9a	88.1a
Standard Error	0.61	0.89	0.67

¹ Within columns means followed by the same or no letter are not significantly different.

Table 5. Performance of starter pigs fed hulled or hulless barley diets.

<u>Diet</u>	<u>Average Daily gain (g)</u>	<u>Average Daily feed (g)</u>	<u>Feed Efficiency</u>
Control	268	548	2.0
Harrington	298	569	1.9
Harrington + Enzyme	295	540	1.8
Scout	281	545	1.9
Scout + Enzyme	283	544	1.9
Standard Error	15	23	.05

USE OF WILD OAT GROATS IN STARTER RATIONS FOR SWINE

P.A. Thacker, G.I. Christison and F.W. Sosulski

INTRODUCTION

Despite intensive efforts at chemical and cultural control, approximately 200,000 tonnes of wild oat seeds are separated annually from grain produced in Western Canada. These wild oats seeds are marketed as Mixed Feed Oats and are utilized almost exclusively in rations for ruminants. The presence of a highly fibrous hull limits their use in diets for monogastrics.

Domestic oat groats (mechanically dehulled oats) are widely utilized in creep and starter rations for swine because they are palatable, highly digestible and contain a relatively low crude fiber content. Recently techniques for dehulling wild oats have been developed. If wild oat groats can be shown to be comparable in nutritional value to domestic oat groats, it could make available to the swine industry a valuable feed resource from a previously unused product.

OBJECTIVES

1. To compare the nutritive value of domestic oat groats and wild oat groats in starter rations for swine.
2. To determine if the nutritive value of domestic oat groats and wild oat groats can be improved by toasting and rolling.

EXPERIMENTAL PLAN

Three replicates of 60, four week old weaner pigs were utilized in this experiment. The experimental animals were assigned on the basis of sex, weight and litter to one of five dietary treatments. The control diet was based on wheat and soybean meal while the remaining diets contained 25% domestic oat groats, wild oat groats, toasted oat flakes (Feed oats) or toasted wild oat flakes added at the expense of wheat (Table 1). All diets were formulated to contain approximately 20% crude protein and synthetic lysine was added so that all diets supplied approximately 0.9% lysine. All other nutrients were present at a level to meet or exceed NRC requirements (Table 2).

The experimental animals were housed in pairs (2 barrows or 2 gilts) in 0.6 x 1.2 m pens with a totally slatted-floor. The pigs were weighed at weekly intervals during the 5 week trial and feed consumption was determined at the time of the weekly weighing.

The digestibility of dry matter, crude protein and energy was determined by the addition of 0.5% chromic oxide to the experimental diets. Six pigs (three barrows and three gilts) were fed one of the chromic oxide containing diets for 10 days. Fecal samples were

collected from each pen during day 9 and 10. Samples of feed and feces were then taken to the laboratory for subsequent analysis.

RESULTS AND DISCUSSION

Table 3 shows the chemical composition of the wheat and oat products used to formulate the experimental diets. The wild oat products contained a significantly higher level of crude protein in comparison with the domestic oat groat and flake. As a result, diets containing either the wild oat groat or flake would require less supplementary protein in order to provide a balanced diet. It is also of interest to note the higher lysine content of the wild oat product compared with that of the domestic oat products. This is important since most cereal-based diets are limiting in lysine.

The performance of starter pigs fed the diets containing various oat products is compared in Table 4. Pigs fed the diet containing oat groats had the highest average daily gain (399 g) followed by pigs fed the wheat-based control diet (393 g), feed oats (378 g), wild oat groats (371 g) and wild oat flakes (350 g). Pigs fed oat groats had the highest daily feed intake (648 g) followed by pigs fed feed oats (646 g), the wheat-based control (644 g), wild oat groats (610 g) and wild oat flakes (598 g). Feed conversion efficiency was approximately the same for all treatments (1.65 g feed/g gain). None of these differences was statistically significant.

Digestibility coefficients for dry matter, crude protein and energy are presented in Table 5. In general, digestibility coefficients were highest for the control diet and lowest for the diet containing wild oat groats. Toasting and rolling produced only marginal improvements in digestibility over that obtained with the unprocessed groat.

CONCLUSIONS AND IMPACT

The growth rate of pigs fed diets containing either wild oat groats or wild oat flakes was similar to that obtained with domestic oat groats and flakes. Toasting and rolling of oat groats or wild oat groats did not appear to improve their nutritional value. However, the performance of pigs fed oat groats was no better than that obtained with a simple wheat and soybean diet which suggests that inclusion of oat groats in starter rations may not be necessary for optimum growth rates.

ACKNOWLEDGEMENTS

This study was supported by the Province of Saskatchewan FarmLab Fund. The authors wish to thank B. Schaen and R. Herman of the Prairie Swine Centre for care and management of the experimental animals.

Table 1. Formulation of experimental diets (2)

Ingredient	Control	Oat Groats	Feed Oat	Wild Oat Groats	Wild Oat Flake
Wheat	79.55	54.06	52.25	58.31	57.66
Soybean meal	13.95	14.44	16.25	10.19	10.84
Oat product	-----	25.00	25.00	25.00	25.00
Limestone	1.25	1.25	1.25	1.25	1.25
Dicalcium phosphate	1.50	1.50	1.50	1.50	1.50
Salt	0.50	0.50	0.50	0.50	0.50
Tallow	2.50	2.50	2.50	2.50	2.50
Vitamin-Mineral premix	0.54	0.58	0.61	0.52	0.53
Synthetic lysine	0.21	0.17	0.14	0.23	0.22

¹Supplied per kg diet: 8250 I.U. vitamin A; 550 I.U. vitamin D₃; 27 I.U. vitamin E; 4 mg vitamin K; 1 mg thiamin; 8 mg riboflavin; 44 mg niacin; 33 mg pantothenic acid; 28 ug vitamin B₁₂; 500 mg choline chloride; 0.25 mg biotin; 6 mg copper; 80 mg iron; 24.7 mg manganese; 153 mg zinc; 0.1 mg selenium; 0.15 mg ethoxyquin.

Table 2. Chemical composition and amino acid analysis of ingredients¹

	<u>Wheat</u>	<u>Oat Groats</u>	<u>Feed Oats</u>	<u>Wild Oat Groats</u>	<u>Wild Oat Flake</u>
<u>Chemical Analysis</u>					
Moisture	12.89	12.73	10.74	11.40	10.17
Crude Protein	15.04	14.53	12.22	19.90	19.06
Ether Extract	1.79	6.33	7.38	7.80	8.74
Crude Fiber	3.03	3.30	1.48	3.80	1.28
Ash	1.60	1.91	1.69	2.20	2.02
Calcium	0.08	0.14	0.05	0.07	0.06
Phosphorus	0.44	0.37	0.40	0.49	0.52
<u>Indispensable Amino Acids²</u>					
Arginine	0.61	0.97	0.81	1.29	1.25
Histidine	0.28	0.31	0.29	0.45	0.43
Isoleucine	0.45	0.50	0.43	0.73	0.64
Leucine	0.91	1.10	0.94	1.47	1.41
Lysine	0.34	0.56	0.50	0.79	0.68
Methionine	0.19	0.17	0.17	0.29	0.27
Phenylalanine	0.64	0.78	0.72	1.13	1.06
Threonine	0.33	0.46	0.32	0.34	0.49
Valine	0.55	0.81	0.68	0.99	1.02

¹As Fed

²Tryptophan not determined

Table 3. Chemical analysis and amino acid composition of diets¹

	<u>Wheat</u>	<u>Oat Groat</u>	<u>Feed Oats</u>	<u>Wild Oat Groat</u>	<u>Wild Oat Flake</u>
<u>Chemical Analysis</u>					
Moisture	10.37	9.92	9.13	10.13	9.91
Crude Protein	20.14	19.33	19.40	19.57	19.88
Ether Extract	4.37	5.40	6.34	5.61	5.87
Ash	4.16	4.20	3.64	3.47	3.90
Acid Detergent Fiber	4.61	4.48	4.01	4.07	4.35
Calcium	0.86	0.88	0.81	0.76	0.78
Phosphorus	0.68	0.69	0.70	0.71	0.72
<u>Indispensable Amino Acids²</u>					
Arginine	1.03	1.10	1.14	1.09	1.09
Histidine	0.53	0.53	0.55	0.52	0.52
Isoleucine	0.75	0.75	0.76	0.72	0.73
Leucine	1.32	1.33	1.39	1.31	1.31
Lysine	0.89	0.89	0.91	0.91	0.91
Methionine	0.30	0.31	0.35	0.32	0.33
Phenylalanine	0.93	0.93	0.95	0.92	0.93
Threonine	0.61	0.63	0.65	0.60	0.61
Valine	0.86	0.88	0.91	0.89	0.89

¹As Fed

²Tryptophan not determined

Table 4. Performance of starter pigs fed various oat products

	<u>Wheat</u>	<u>Oat Groats</u>	<u>Feed Oats</u>	<u>Wild Oat Groats</u>	<u>Wild Oat Flake</u>
Average daily gain (g)	393	399	378	371	350
Average daily feed (g)	644	648	646	610	598
Feed efficiency	1.64	1.62	1.70	1.64	1.70

Table 5. Digestibility coefficients for dry matter, crude protein and energy

	<u>Wheat</u>	<u>Oat Groats</u>	<u>Feed Oats</u>	<u>Wild Oat Groats</u>	<u>Wild Oat Flake</u>
Dry matter (%)	88.14	87.08	87.29	82.19	85.42
Crude protein (%)	85.84	82.99	83.65	78.40	81.33
Energy (%)	87.33	86.37	86.22	79.92	83.92

C. PAPERS PREPARED AND TALKS GIVEN

- P.A. Thacker, Sosulski, F.A. and Campbell, G.L., 1986. Potential of Wild Oat Groats as a Feed Ingredient for Use in Livestock Production. Proceedings 7th Western Nutrition Conference Saskatoon, Saskatchewan, September pp 74-82.
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- P.A. Thacker, 1986. Questions on Nutrition Column: Use of Wild Oats in Swine Rations. Western Hog Journal, 3(2):24-29.
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Agricultural Development Fund

Project #R-86-01-0066

"An Evaluation of Alternative Energy Sources for Swine"

Personnel Distribution Listing

J.A. Malone	Research Assistant	20%
J. Eade	Graduate Student	33%
B. Schaan	Herdsmen	80%

UNIVERSITY OF SASKATCHEWAN
Saskatchewan Agriculture
"An Evaluation of Alternative Energy Sources for Swine"
Under the Direction of D.A. Christensen, Animal & Poultry Science
Statement of Receipts & Expenditures for the Period
July 16, 1986 - February 28, 1987

Receipts

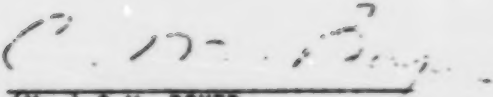
Saskatchewan Agriculture - August 1986 \$56,000

Expenditures

Salaries	\$3,121	
Fringe Benefits	163	
Materials & Supplies	7,576	
Travel	<u>76</u>	<u>10,936</u>

Unexpended Balance as of February 28, 1987 \$45,064


PROJECT DIRECTOR


(Ms.) C.M. BOYER
RESEARCH ACCOUNTANT

Agricultural Development Fund

Project #R-86-01-0066

"An Evaluation of Alternative Energy Sources for Swine"

Financial Projection to March 31, 1987

Salaries and Benefits	29,000
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Materials and Supplies, including swine maintenance costs	31,000
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Equipment	*4,000
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\$64,000

*Please note there is an outstanding Purchase Order for approximately \$4,000 for which we have been unable to obtain an invoice to meet the University "cut-off" date.